Perspectives for charmonium measurements at the LHC with the ALICE upgrade program*

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Among the various suggested probes of deconfinement, charmonium plays a distinctive role. It is the first hadron for which a clear mechanism of suppression in deconfined matter (QGP) was proposed early on, based on the color analogue of Debye screening [1]. The idea of statistical hadronization of charm quarks in nucleus-nucleus collisions [2] has gained support from data, in particular that recently measured at the LHC [4]. An alternative mechanism of quarkonium production (and destruction), that during the entire lifetime of the QGP (realized in a transport approach, see [3] and refs. therein) is also able to reproduce the RHIC and LHC data. Based on these observations, the J/ψ production can be considered a probe of QGP as initially proposed [1], but may not be a "thermometer" of the medium. Discriminating the two pictures implies providing an answer to fundamental questions related to the fate of hadrons in a hot medium.

High-quality J/ψ data over broad ranges in $p_{\rm T}$ and y and a precision measurement of $\psi(2S)$ and χ_c charmonium states could allow this and is a major component of physics envisaged with the ALICE Upgrade Project [5]. The unique capability of the ALICE detector is to measure charmonium production down to $p_{\rm T}$ =0. This will be complemented by a challenging data taking at very high rate. In the following we present estimates of the performance of the ALICE measurement of J/ψ and $\psi(2S)$ in the Central Barrel ($|y|$ <0.9, measurement done in the e^+e^- channel). The measurement performance has been estimated for integrated luminosities of 1 nb^{-1} and 10 nb^{-1}, corresponding to the data sample expected for the baseline ALICE data taking and after the upgrade, respectively.

The expected absolute statistical error of the elliptic flow (v_2) measurement is shown in Figure 1 (a $v_2^{J/\psi}$ magnitude in the range 0.06-0.1 is expected around $p_{\rm T}$ =3 GeV/c [6]). The measurement of elliptic flow of J/ψ is only possible with the 10 nb^{-1} Pb-Pb data (10^{10} collisions) expected with the upgrade. A measurement with a good significance over a broad range in $p_{\rm T}$ (up to 5-6 GeV/c) can be achieved with the usage of the TRD electron identification. In this case, a direct measurement of elliptic flow of J/ψ from B hadrons could become also feasible.

In the dielectron channel the measurement of $\psi(2S)$ production is challenging and can be achieved with good significance only with the 10 nb^{-1} Pb-Pb data expected with the full upgrade, see Figure 2. Such a measurement will allow, together with the measurement in the dimuon channel, to disentangle between a statistical production at the phase boundary [2] and production during the QGP lifetime [3].

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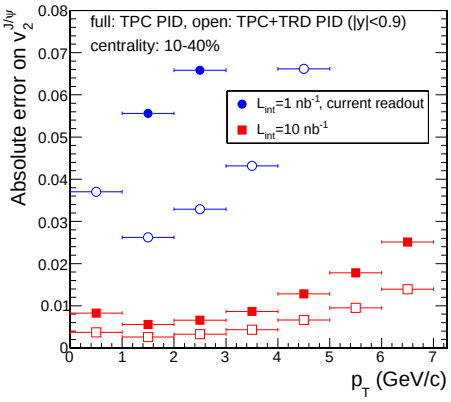

Figure 1: The absolute statistical error of the elliptic flow of J/ψ $v_2^{J/\psi}$ as a function of transverse momentum for the centrality range 10-40%.

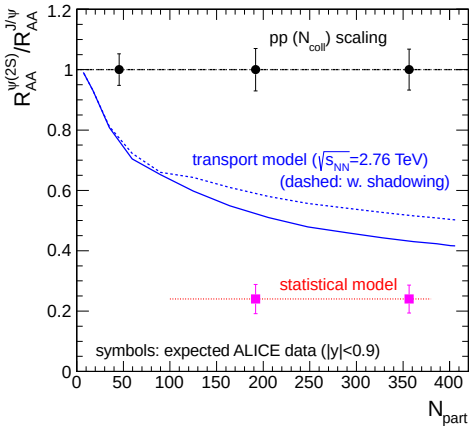

Figure 2: Centrality dependence of the expected statistical error of the $\psi(2S)$ measurement in the Central Barrel with 10 nb^{-1} Pb-Pb data in the hypothesis of pp scaling and of the statistical model production for the ratio of nuclear modification factors of $\psi(2S)$ and J/ψ.

References

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